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Rijssemus

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(54) **SIGNAL SPLITTER FOR USE IN MOCA/CATV NETWORKS**

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H03H 7/42	(2006.01)
H03H 7/48	(2006.01)
H04N 7/10	(2006.01)
H03H 7/06	(2006.01)
H03H 7/01	(2006.01)

(52) **U.S. Cl.**

CPC ***H03H 7/42*** (2013.01); ***H03H 7/482*** (2013.01); ***H04N 7/104*** (2013.01); *H03H 7/06* (2013.01); *H03H 7/1791* (2013.01)

(58) **Field of Classification Search**

CPC H03H 7/42; H03H 7/485; H03H 7/06; H03H 7/1791; H04N 7/104
USPC 333/131, 124, 25, 26
See application file for complete search history.

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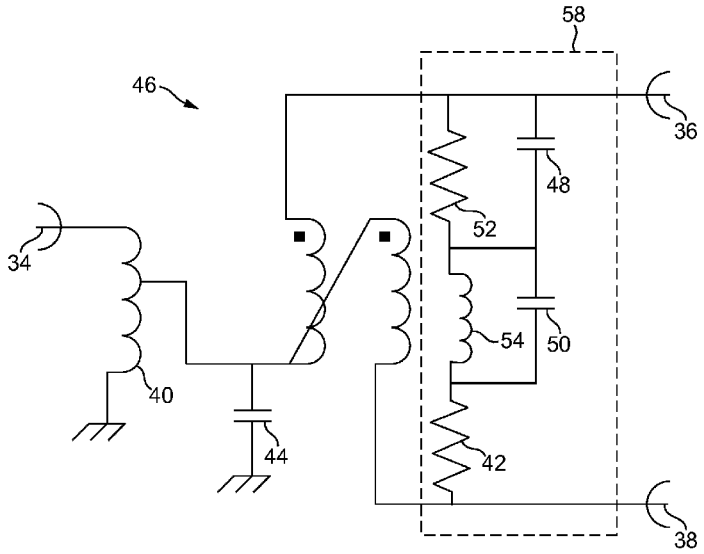
(57) **ABSTRACT**

There is provided a splitter circuit means for use with a CATV network comprising a signal input (**34**) in communication with a transformer or balun (**32**) to supply two signal outputs (**36**, **38**), with a resistor (**52**) connected in parallel between the outputs (**36**, **38**) and wherein additional capacitive, inductive and resistive elements (**48**, **50**, **52**, **54**) are associated with the resistor (**42**), thereby to give an insertion loss in to out in the range of 3 to 10 dB and isolation **10** out to out of <17 dB for signal frequencies in the range 1125 MHz to 1700 MHz, while at the same time maintaining good RF performance in the frequency range 5 MHz to 1000 MHz.

18 Claims, 2 Drawing Sheets



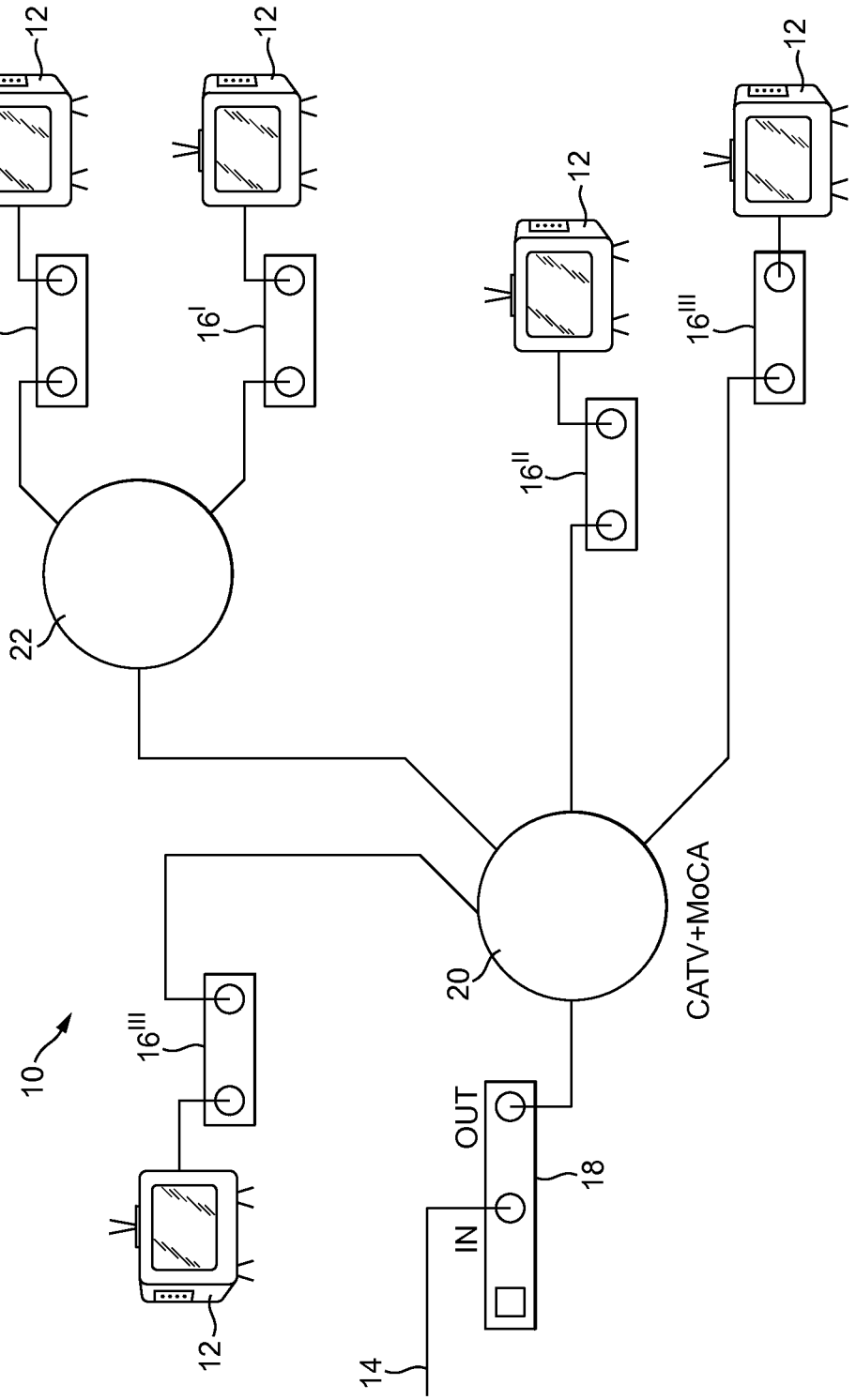


FIG. 1

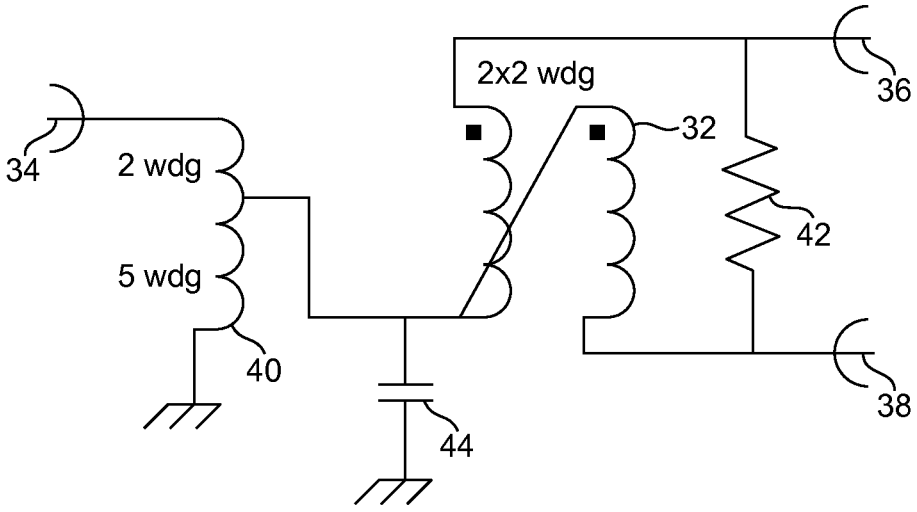

2x2 wdg
36
34
2 wdg
32
42
5 wdg
40
38
44

FIG. 2

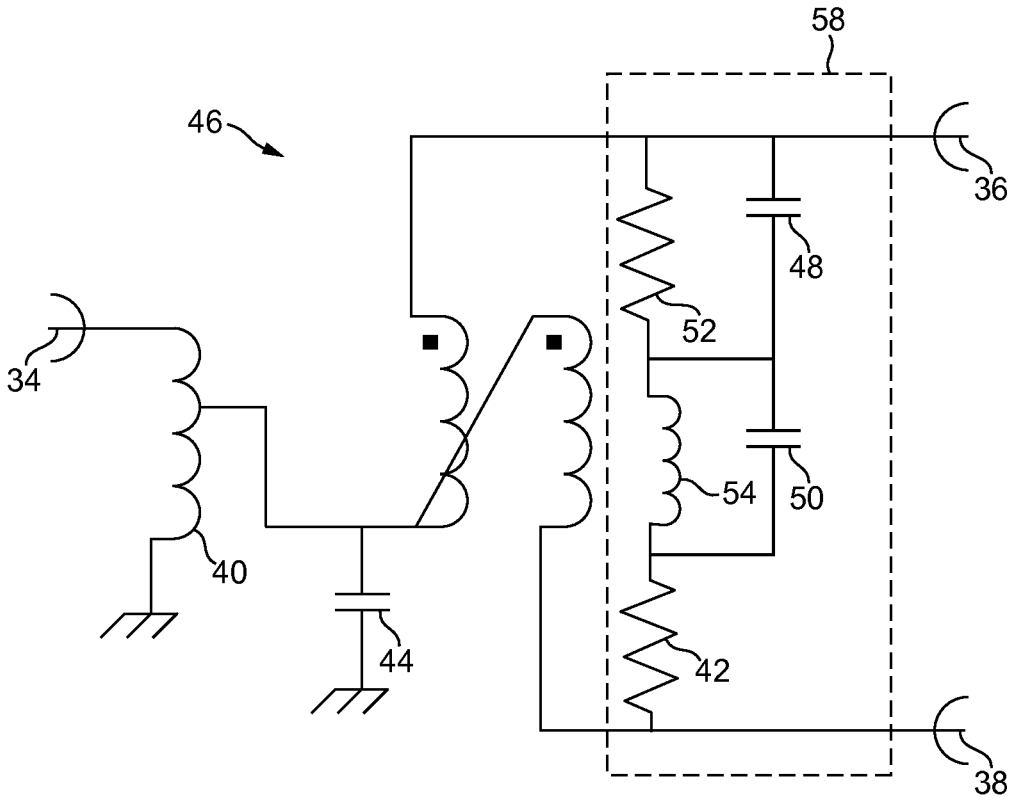

58
46
36
48
52
34
54
50
40
42
44
38

FIG. 3

SIGNAL SPLITTER FOR USE IN MOCA/CATV NETWORKS

FIELD OF THE INVENTION

This invention relates to a signal splitter for use in MoCA/CATV networks, the associated circuitry and a cable television network incorporating such signal splitters.

BACKGROUND TO THE INVENTION

A signal splitter, also known as a power splitter, for use in networks where CATV (cable television) transmission is combined with MoCA (Multimedia over Coax Alliance) transmission should have good return loss, low insertion loss and high isolation in the CATV frequency range (typically 5 MHz to 1000 MHz) to give excellent RF performance.

However for the MoCA frequency range which in the future is expected to range from is typically 1125 MHz to 1700 MHz, the signal splitter should ideally have a low isolation as well as a low insertion loss so as to reduce transmission loss and thus improve or, in some cases, enable MoCA transmission between output ports of a plurality of splitters within an in-home network.

Most homes have an in-home coaxial network installed to distribute TV signals to various locations. This network can also be used to distribute data or other signals to and from these locations.

With the increasing use of IP (Internet Protocol) and the internet, in-home networking is becoming very important and whilst there may be an access point in the home, it can be difficult to distribute data from this access point to and from various locations in the home. There are several technologies available to achieve this, for example PowerLine, MoCA, wireless, fibre optic, and CAT-5. These technologies all have their weaknesses.

The advantages of using the existing in-home coaxial networks are obvious: no new wires are needed and the coaxial cable is a medium with large bandwidth and very good screening. It is therefore a safe and fast medium and since it is already in place, it is also an economical solution.

However the signal dividers used in existing coaxial networks have a high isolation between output ports making two-way MoCA communication very difficult and in many cases even impossible.

It is an aim of the present invention to provide a signal splitter and associated circuit means to combine suitable RF performance in the CATV frequency range with low isolation in the MoCA frequency range.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a splitter circuit means for use with a CATV network comprising a signal input in is communication with a transformer or balun to supply two signal outputs, with a first resistor connected in parallel between the outputs and wherein a filter unit comprising a single inductive element, capacitive and resistive elements is associated with the first resistor, thereby to give an insertion loss in to out in the range of 3 to 10 dB, and preferably an isolation out to out of <17 dB, for signal frequencies in the range 1125 MHz to 1700 MHz. The frequency band of 1125 to 1700 MHz is the preferred MoCA bandwidth and a splitter circuit with a low insertion loss over this frequency range improves MoCA transmission between output ports of associated splitter circuits.

Preferably the filter unit is connected in series with the first resistor thereby to prevent signals flowing through the first resistor for signal frequencies in the range 1125 MHz to 1700 MHz.

Preferably two capacitive elements, a second resistor and an inductive element are connected in parallel with the first resistor. Preferably the two capacitive elements are in series with each other and in parallel with the second resistor and inductive element. A signal splitter incorporating such a circuit will have low isolation, low insertion loss and moderate return loss for signals within the MoCA frequency range.

Desirably the inductive element has an inductance in the range 10 nH to 20 nH, more preferably 3 nH to 11 nH.

The first capacitive element may have a capacitance in the range 2 pF to 5 pF, more preferably in the range 1 pF to 2.5 pF, with the second capacitive element preferably having a capacitance in the range 0.1 pF to 3 pF, more preferably 1 pF to 1.5 pF.

The second resistor may have a resistance in the range 100 to 50 Ohm, more preferably 90 to 75 Ohm, where the first resistor has a value in the range 150 to 50 Ohm, more preferably 110 to 70 Ohm. Typically the narrower range of values applies where the splitter circuit means is incorporated into a two-way splitter, the broader range applying for four-way splitters.

The splitter circuit means preferably has an insertion loss in to out in the range 3 to 6 dB for frequencies in the range 5 to 1000 MHz and an insertion loss in to out of 3 to 10 dB for frequencies in the range 1125 MHz to 1700 MHz. The splitter circuit means preferably has an isolation port to port of >20 dB for frequencies in the range 5 to 1000 MHz and <17 dB in the frequency range 1125 to 1700 MHz. The splitter circuit means thus is able to have suitable RF performance in the CATV frequency range while at the same time having low insertion loss, low isolation and moderate return loss for signals in the MoCA frequency range.

The invention also lies in a signal splitter incorporating at least one splitter circuit means as aforesaid, so giving two output ports which are typically associated with subscriber equipment. In such a signal splitter, the single inductive element may have an inductance in the range 10 nH to 20 nH, the first capacitive element may have a capacitance in the range 2 pF to 5 pF and the second capacitive element may have a capacitance in the range 0.1 pF to 3 pF, with the second resistor preferably having a resistance in the range 100 to 50 Ohm.

The signal splitter may incorporate a plurality of splitter circuit means as aforesaid so as to provide additional output ports. Typically one splitter circuit means in accordance with the invention will be connected to two splitters to provide a four-way splitter in accordance with the invention.

For signal splitters in which splitter circuits are combined to give 4, 6, 8, 10 or more ports, the values for the inductive, capacitive and resistive elements will need to be selected to ensure the desired insertion loss in to out of between 3 to 10 dB and an isolation out to out of <17 dB is achieved in the MoCA frequency range.

In accordance with another aspect of the present invention, there is also provided a cable television network incorporating one or more splitter circuit means or signal splitters as aforesaid.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. **1** shows a schematic diagram of an in-home CATV and MoCA network;

FIG. **2** shows a prior art two-way splitter; and

FIG. **3** shows a signal splitter in accordance with the present invention.

DESCRIPTION

A typical in-home CATV+MoCA network configuration **10** is shown in FIG. **1**.

Within the home of a subscriber are a number of devices **12**, such as televisions which receive a signal from a CATV network **14** and are capable of returning modified signals to the network through set-top boxes **16** which are connected via splitters to a modem **18** which receives and transmits signals to and from the CATV network **14**. Within the home, there is typically more than one device receiving the signal from the CATV network and to supply a signal to each item of subscriber equipment, a four-way splitter **20** splits the incoming signal to feed a variety of devices, with if required signals from the four-way splitter being split again, for example by two-way splitter **22**. These splitters act to combine the signals returned from the consumer's devices.

The signal or power splitter used in this type of combined CATV/MoCA network should have the normal specification for the CATV frequency range as these channels pass through the modem **18** (from IN to OUT) and are transmitted throughout the in-home network **10**.

For transmission in the MoCA frequency range to be achieved, it is necessary to have a lower isolation between the output ports of the power splitters **20**, **22** as this will lower the transmission loss. For example: suppose set-top box **16** transmits to set-top box **16'''**. The MoCA transmission loss will be:

insertion loss two-way splitter **22**+cable losses+isolation of four-way splitter **20**

For MoCA transmission from set-top box **16** to set-top box **16'** this would be:

cable loss+isolation of two-way splitter **22**

For MoCA transmission from modem **18** to set-top box **16** the losses will be:

insertion loss four-way splitter **20**+cable losses+insertion loss two-way splitter **22**.

Since the frequency of MoCA is high, the cable losses are significant but cannot be avoided. These high cable losses pose yet another problem: the return loss in the MoCA frequency range at the input of the two-way splitter will be on average:

return loss four-way splitter **22**+2 times cable loss between two-way **22** and four-way splitter **20**

This will increase the isolation between outputs of the two-way splitter **22** and as such increase transmission loss between certain points in the network **10**.

A typical prior art two-way signal divider **30** will have a topology as shown in FIG. **2**. This splitter comprises a transformer in the form of a (typical) 2×2 winding 180 degree balun (balanced to unbalance to converter) **32**, also known in the art as a 'fork', which splits the signal from an input **34** to provide separate signals to two customer outputs **36**, **38**. The impedance at the centrepoint of the balun **32** is half of the input impedance 75 Ohm and the impedances of the outputs **36**, **38**, each again 75 Ohm, and in the case of a cable TV splitter is 37.5 Ohm. A resistor **42** is connected in parallel with the balun **32** and typically has a value of 150 Ohm. Frequency response compensation of the circuit is achieved by means of capacitor **44** which typically has a capacitance of around 2 pF. A step-up transformer **40** split at (typically) 2 windings and 5 windings is placed in series between the input **34** and the balun **32**, transferring the 37.5 Ohm impedance (at the centre tap of balun **32**) to 75 Ohm at the input.

This kind of divider has good return loss on all ports and high isolation between output ports. This is not suitable for in-home signal transmission when CATV transmission is combined with MoCA transmission in the frequency range up to 1700 MHz as if the transmission loss of MoCA in the in-home network is to be lowered for the MoCA frequency range the following is required:

low isolation between output ports

low insertion loss from in to out

with a moderate return loss being acceptable.

A standard four-way power splitter is created from three standard two-way splitters as basic building blocks, as is known in the art.

FIG. **3** shows a power splitter configuration in accordance with the present invention that does not have the disadvantages of the prior art power splitter shown in FIG. **2** when used in an in-home coaxial network in which CATV transmission and MoCA transmission are combined. In the signal splitter **46** shown in FIG. **3**, capacitors **48**, **50**, resistive element, namely resistor **52**, and inductor **54** are added to the resistor feedback circuit in the topology shown.

The resistor **52** is connected in series with inductor **54** and these two elements are in turn in parallel with series capacitors **48** and **50**, with a connection between the joining points of capacitors **48**, **50** and the joining points of resistor **52** and inductor **54**. The filter unit made from the capacitors **48**, **50**, resistor **52** and inductor **54** is in turn connected to resistor **42**, such that resistor **42** is in series with the filter unit. The filter unit prevents signals flowing through the isolating resistor **42** over the frequency range 1125 MHz to 1700 MHz and by blocking this signal path, the isolation of the splitter is greatly reduced.

The feedback circuit **58** acts as a filter with no or little influence at the CATV frequency range from 5 MHz to 1000 MHz but with low insertion loss in the MoCA frequency range from 1125 MHz up to, or even beyond, 1700 MHz. This will lower the isolation in the MoCA frequency range while, at the same time, maintaining low insertion loss, moderate return loss and excellent RF performance in the CATV frequency range 5 MHz to 1000 MHz. Typically for frequencies in the range 1125 MHz to 1700 MHz, the circuit/splitter has an insertion loss in to out in the range 3 to 10 dB, and isolation out to out of <17 dB.

Typical values for the components are:

Resistor **42**: 150 to 50 Ohm, more preferably 100 Ohm

Resistor **52**: 100 to 50 Ohm, more preferably 82 Ohm

Capacitor **44**: depending on the ferrite used and the windings, but typically 1.5 pF to 2.2 pF

Capacitor **48**: 1 pF to 2.5 pF, preferably 2.2 pF

Capacitor **50**: 1 pF to 1.5 pF

Inductor **54**: 3 to 11 nH, typically 1.5 turns of 0.33 mm Cu wire with diameter of 2 mm to 3 mm

This circuit is a simple implementation and so can be manufactured using shorter PCB tracks and less PCB surface than more complicated circuits. Using shorter tracks, avoids performance being degraded at higher frequencies such as 1700 MHz. Also, because there is only a single inductor, physical alignment of the value of inductors by bending inductor windings to be more open or closed is easier than if two inductors were used.

The splitter described can be used to make a four-way power splitter or any other multiple splitter from two-way splitters as basic building blocks. The feedback circuit **58** can be used as the basic difference with a standard multiple output CATV splitter.

When using the splitter of FIG. **3**, the transmission characteristics in the CATV frequency range are substantially not

affected while, at the same time, the transmission loss in the MoCA frequency range improves. This is also true when more power splitters are cascaded as in a larger network or when two-way power splitters are used as basic building blocks in a four-way splitter.

This power splitter has excellent RF performance in the CATV frequency range while at the same time having low isolation, low insertion loss and moderate return loss for the MoCA frequency range up to 1700 MHz.

The invention claimed is:

1. A splitter circuit for use with a CATV network comprising a signal input in communication with a transformer or balun to supply two signal outputs, with a first resistor connected in parallel between the outputs and wherein a filter unit connected in series with the first resistor comprises a single inductive element, two capacitive elements and a second resistor connected in parallel with the first resistor, thereby to give an in-to-out insertion loss in the range of 3 to 10 dB, for signal frequencies in the range 1125 MHz to 1700 MHz.

2. A splitter circuit according to claim **1**, wherein the two capacitive elements are in series with each other and in parallel with the second resistor and inductive element.

3. A splitter circuit according to claim **1**, wherein the single inductive element has an inductance in the range 10 to 20 nH.

4. A splitter circuit according to claim **1**, wherein the first capacitive element has a capacitance in the range 2 pF to 5 pF with the second capacitive element having a capacitance in the range 0.1 pF to 3 pF.

5. A splitter circuit according to claim **1**, wherein the second resistor has a resistance in the range 100 to 50 Ohm.

6. A splitter circuit according to claim **1**, wherein the splitter circuit has an in-to-out insertion loss in the range 3 to 6 dB for signal frequencies in the range 5 MHz to 1000 MHz.

7. A splitter circuit according to claim **1**, having an isolation out to out of <17 dB for frequencies in the range 1125 MHz to 1700 MHz.

8. A signal splitter incorporating at least one splitter circuit according to claim **1**.

9. A cable television network incorporating one or more splitter circuit according to claim **1**.

10. A splitter circuit for use with a CATV network comprising a signal input in communication with a transformer or balun to supply two signal outputs, with a first resistor connected in parallel between the outputs and a filter unit connected in series with the first resistor, wherein the filter unit comprises a single inductive element, two capacitive elements, and a second resistor, wherein the single inductive element is in parallel with a first capacitive element of the two capacitive elements and the second resistor is in parallel with a second capacitive element of the two capacitive elements, thereby to give an in-to-out insertion loss in the range of 3 to 10 dB, for signal frequencies in the range 1125 MHz to 1700 MHz.

11. A splitter circuit according to claim **10**, wherein the two capacitive elements are in series with each other.

12. A splitter circuit according to claim **10**, wherein the single inductive element has an inductance in the range 10 to 20 nH.

13. A splitter circuit according to claim **10**, wherein the first capacitive element has a capacitance in the range 0.1 pF to 3 pF and the second capacitive element has a capacitance in the range 2 pF to 5 pF.

14. A splitter circuit according to claim **10**, wherein the second resistor has a resistance in the range 100 to 50 Ohm.

15. A splitter circuit according to claim **10**, wherein the splitter circuit has an in-to-out insertion loss in the range 3 to 6 dB for signal frequencies in the range 5 MHz to 1000 MHz.

16. A splitter circuit according to claim **10**, having an isolation out to out of <17 dB for frequencies in the range 1125 MHz to 1700 MHz.

17. A signal splitter incorporating at least one splitter circuit according to claim **10**.

18. A cable television network incorporating one or more splitter circuit according to claim **10**.

* * * * *